Excerpt from

Proceedings of the Energy Efficiency Policy Symposium

November 9, 2000 • Honolulu, Hawaii

http://www.hawaii.gov/dbedt/ert/symposium

The Economics of Energy Efficiency and Renewable Energy

Dr. Leroy Laney

Professor of Economics and Finance, Hawaii Pacific University

Dr. Laney joined the HPU faculty as a Full Professor in 1998, after a broad ranging background in banking, government, and other academic positions.

He has served as a Staff Economist on the President's Council of Economic Advisers in Washington, D.C., as an International Economist with the U.S. Treasury in Washington, and as a Senior Economist in the Federal Reserve System.

His academic experience includes adjunct teaching positions at the University of Colorado at Boulder, Southern Methodist University, the University of Texas (Arlington and Dallas campuses), and the University of Hawaii at Manoa. He also held a joint appointment in the Economics and Finance Departments at Butler University in Indianapolis during the 1989-1990 academic year, and served there as Chairman of the Economics Department.

From 1990 through 1998, his position was Senior Vice President and Chief Economist for First Hawaiian Bank in Honolulu. There he held a highly visible position as the Bank's spokesman on all international, national, and local economic matters. He has served as Chairman of the Council on Revenues of the State of Hawaii, and as a member of the Market Research Committee of the Hawaii Visitors and Convention Bureau.

Professor Laney has published widely in academic journals, Federal Reserve and other bank publications, and in edited volumes and conference proceedings. He remains a Consultant to First Hawaiian Bank, and has also consulted with the University of Hawaii Economic Research Organization, Alexander & Baldwin, Inc., Matson Navigation Company, Colliers Monroe and Friedlander, The Estate of James Campbell, the Waikiki Improvement Association, the State of Hawaii, and the County of Hawaii. He is a member of Who's Who in America, Who's Who in the World, Who's Who in Finance and Industry, Who's Who in the West, the American Economic Association, the Western Economic Association, the National Association for Business Economics, and Lambda Alpha real estate honorary.

His Ph.D. in Economics is from the University of Colorado at Boulder. He also holds a Bachelor of Industrial Engineering from Georgia Tech, and an MBA in accounting and finance from Emory University.

From 1967 to 1971, he served as a Lieutenant in the U.S. Navy Supply Corps. Dr. Laney is married to the former Sandra Prescott of Atlanta, and has two sons.

A Peer Review of <u>The Economic and Fiscal Impacts of the Hawaii Energy Conservation Income Tax Credit</u> By Thomas A. Loudat, Ph.D., Revised January 27, 1997

Submitted by:

Leroy O. Laney, Ph.D.
Professor of Economics and Finance
Hawaii Pacific University

Introduction

This peer review of the subject paper has been commissioned by the Energy, Resources, and Technology Division of the State of Hawaii's Department of Business, Economic Development, and Tourism (DBED&T). The overall purpose is to provide an objective critique of Dr. Thomas Loudat's earlier paper for an Energy Symposium held at Hawaii Electric Company on November 9, 2000.

This review paper will proceed to discuss the Loudat paper in the order that it is written. Then some supplementary empirical results from the author's own investigations will be presented, and finally some thoughts on Hawaii's energy policy options will be offered.

Overview of Findings

The purpose of the Loudat paper is to provide a quantitative assessment of the impact of the State of Hawaii's Energy Conservation Income Tax Credit (ECITC) on investment in solar energy systems. This tax credit has been in effect since 1977, even though the percentage of the tax credit allowed has varied over time. Upon its introduction in 1977, the credit was 10 percent. Then it was raised to 50 percent in the years 1978 through 1985. As oil prices collapsed in the mid-1980s, the credit was lowered to 10 percent again for one year in 1986. Since then, the credit was15 percent over the 1987-1989 period, and it has been kept at 35 percent since 1990. It is fairly obvious that the amount of the credit has been influenced by the level of overall energy prices throughout its existence.

Loudat begins his paper by emphasizing the investment nature of the decision to purchase a solar system, projecting benefits out over a 25-year life span of a given system. Then, in an Executive Summary, he lists research assumptions and major conclusions. These conclusions include findings of positive fiscal and employment impacts of the ECITC program, plus an estimate that the solar industry will shrink to 59 percent of its current size if the ECITC is eliminated, even if Hawaiian Electric's current Demand Side Management (DSM) program remains in place. In contrast, if both the ECITC and DSM remain, the industry is projected to grow by up to 70 percent.

He further estimates that the State government's ECITC expenditures generate ten times that amount of overall economic output, one job per ten installed systems, and labor income of over three times the original ECITC expenditure.

These estimated benefits naturally depend on the assumed level of future energy prices. An oil crisis such as occurred during the 1975-1985 period is calculated to increase the above estimated economic and fiscal impacts by 20 to 300 percent, depending on when such crisis occurs during the life of a system.

Loudat's analysis does not attempt to measure the avoided negative externalities of continuing to burn fossil fuels. He does mention that such externalities are particularly important to an economy like Hawaii, where tourism and the environment are of such critical importance.

Summary of Analysis

It is not possible to recount all of the detailed analysis of the Loudat paper itself here; the reader is referred to that paper for those details. This section briefly reviews the highlights and assumptions of that analysis, commenting upon them where that is appropriate.

Basically, Loudat uses the State of Hawaii Input/Output model published and maintained by DBED&T to assess the economic and fiscal impacts of both costs and benefits of the ECITC expenditure. Purchase of the solar system is viewed as a 25-year investment, and Loudat considers alternative impacts if the system is cash-financed versus borrowing-financed. (If a system is borrowing-financed, overall economic benefits improve slightly but are shifted to later years.)

The economic benefit of a solar system is the stimulus it provides to an individual to purchase a solar system, as well as this purchase's consequent economic and fiscal impacts. The costs of the ECITC are the economic and fiscal impacts of purchasing fossil fuel generated energy, foregone due to the purchase of a solar system. If the ECITC is eliminated, other economic and fiscal costs would be incurred due to the estimated reduction in the size of the solar industry.

Total economic and fiscal impacts of the ECITC are calculated by multiplying the per system impacts by the estimated number of systems. This estimated number of systems depends not only on the size of the ECITC, but also on the supplemental help of the DSM program.

An oil crisis, such as occurred between 1975 and 1985, would cause electricity rate increases much greater than assumed in the base case scenario. Such rate increases mean additional energy costs savings to purchasers of solar systems, as well as added positive economic and fiscal impacts. If the oil crisis occurs early in the life of the system purchased, these positive impacts will be greater than if the crisis occurs later in its life. The reader is referred to the paper for specific assumptions and conclusions from them.

Loudat concludes his description of the analysis by outlining in detail several economic and fiscal impacts not measured by the analysis. Understandably, most of these impacts would be difficult to quantify:

- There would be a negative impact on Hawaii's position as a Pacific Basin energy development and implementation leader. (Hawaii has the highest per capita number of solar systems in the nation.)
- There would likely be a negative impact on business investment in Hawaii due to vacillating state policy, which reduces certainty of return on that investment.
- Negative impacts of such things as unemployment insurance costs and retraining are not included.
- Positive impacts of permit fees and property tax revenues are not measured.
- Positive externalities from reduced oil consumption are not included. (If the cost of these negative consequences were incorporated into the price of oil, the energy costs savings would be significantly larger. And the larger the energy costs savings, the larger are the positive economic and fiscal impact of the ECITC.)

Critique of the Paper

As any economist who has ever conducted an analysis such as that presented in the Loudat study knows, conclusions are often very sensitive to the assumptions made. Yet, the analyst is forced to make

many such assumptions in order to proceed with the analysis. This particular paper might be called into question because the study was conducted for the Hawaii Solar Energy Association.

Still, this reviewer finds the assumptions and conclusions from them to be reasonable and sound. Furthermore, the analysis appears to have been conducted carefully and in great detail.

This does not deny that other analyses, with other assumptions, might reach different conclusions. Yet in the absence of other work, the burden of proof is still upon those who challenge the results of the current paper. Loudat is currently preparing an updated and revised version of the paper reviewed here. That revised paper may include other salient points that either reinforce or diminish the findings of this reviewed paper. Upon this writing, this reviewer has not seen the revised paper.

Regression Analysis of the Impact of Solar Tax Credits

While the above assumptions and conclusions are important in assessing the total net economic and fiscal impacts of the ECITC, the critical question is: Are solar tax credits effective in stimulating investment in solar energy systems? An answer to this question is important because individuals might be motivated, at least to a certain extent, by other external circumstances to invest in solar systems even without the ECITC.

For example, just the existence of higher energy prices alone could motivate a decision to invest in a solar system, because savings would exist even without a tax credit such as the ECITC. And clearly the percentage amount of the tax credit has varied with the level of energy prices over the life of the credit, so effects might potentially be hard to attribute to individual causal factors. Any public policy decision has to consider the incremental impact of that policy over and above what would occur just because of existing market forces.

Loudat attempts to address the causal impact of the tax credit on solar systems sold with a regression analysis presented on paper 18 of his paper. In that regression, one independent variable – the percentage amount of the solar tax credit – is regressed upon a dependent variable specified as the annual number of systems sold. The interval of available data at the time of the paper was 1977 to 1992.

The outcome of the regression suggests a high degree of causal impact. The adjusted R-squared is .73, and the t-statistic on the independent variable, at 6.37, is highly significant. By regressing his data in double log formulation, Loudat is able to interpret the coefficient on the single independent variable as an elasticity. The value of that coefficient indicates that, on average over the life of the ECITC, every one percent increase in the amount of the tax credit results in a 1.5 percent increase in the number of systems sold.

While this outcome constitutes tangible evidence that the credit has indeed been effective in stimulating investment in solar systems, it might be considered by some to be incomplete. That is, did investors perhaps purchase solar systems just because energy prices were higher, not so much because of the existence of the tax credit? In addition, if the purchase was borrowing financed, did the level of interest rates affect the purchase decision? These questions cannot be addressed directly with the existing regression work in the paper.

This reviewer undertook further regression analysis to address such questions specifically. Results are presented in Exhibits I through III.

Exhibit I is simply a replication of Loudat's regression, with the tax credit as the single independent variable and systems sold as the dependent variable. Outcomes are indeed the same as in the Loudat paper.

year	systems sold		tax credit	
1977	1101	7.003974137	10	2.302585093
1978	4061	8.309184528	50	3.912023005
1979	4375	8.383661799	50	3.912023005
1980	4704	8.45616849	50	3.912023005
1981	6445	8.771059915	50	3.912023005
1982	4407	8.390949465	50	3.912023005
1983	3148	8.05452261	50	3.912023005
1984	4464	8.403800504	50	3.912023005
1985	6740	8.815815204	50	3.912023005
1986	592	6.383506635	10	2.302585093
1987	354	5.869296913	15	2.708050201
1988	316	5.755742214	15	2.708050201
1989	327	5.789960171	15	2.708050201
1990	1180	7.073269717	35	3.555348061
1991	1314	7.180831199	35	3.555348061
1992	1261	7.139660336	35	3.555348061

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.862287047
R Square	0.743538951
Adjusted R Square	0.725220304
Standard Error	0.576523042
Observations	16

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	13.49098579	13.49098579	40.58918631	1.74E-05
Residual	14	4.653303458	0.332378818		
Total	15	18.14428924			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	2.364748	0.816713	2.895443	0.011747	0.613069	4.116427	0.613069	4.116427
tax credit	1.498319	0.235179	6.370964	1.74E-05	0.993909	2.002729	0.993909	2.002729

EXHIBIT I

Exhibit II adds two other variables to Loudat's regression – the average annual price per barrel of crude oil and an interest rate. In this exhibit, the interval was kept the same for comparison to Loudat's results. Again, data regressed was in log-linear form.

Year	systems sold	tax credit	oil price	interest rate
1977	7.003974137	2.302585093	2.586259144	1.944480556
1978	8.309184528	3.912023005	2.59450816	2.118662255
1979	8.383661799	3.912023005	3.408172995	2.253394849
1980	8.45616849	3.912023005	3.602231647	2.440606391
1981	8.771059915	3.912023005	3.563032744	2.656054906
1982	8.390949465	3.912023005	3.479700443	2.565718293
1983	8.05452261	3.912023005	3.3891248	2.379546134
1984	8.403800504	3.912023005	3.351656936	2.504709277
1985	8.815815204	3.912023005	3.309447523	2.315501318
1986	6.383506635	2.302585093	2.651127054	1.989243274
1987	5.869296913	2.708050201	2.901421594	2.071913275
1988	5.755742214	2.708050201	2.692598097	2.136530509
1989	5.789960171	2.708050201	2.885359216	2.140066163
1990	7.073269717	3.555348061	3.135059339	2.124653885
1991	7.180831199	3.555348061	2.963725477	1.997417706
1992	7.139660336	3.555348061	2.946542029	1.822935087

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.880888846
R Square	0.775965158
Adjusted R Square	0.719956448
Standard Error	0.58201897
Observations	16

ANOVA

	df	SS	MS	F	Significance F
Regression	3	14.07933627	4.693112091	13.85436572	3.33E-04
Residual	12	4.064952971	0.338746081		
Total	15	18.14428924			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	1.049059	1.446790	0.725094	0.482294	-2.103226	4.201346	-2.103226	4.201346
tax credit	1.321892	0.362136	3.650255	0.003325	0.532863	2.110921	0.532863	2.110921
oil price	-0.283529	0.882287	-0.321357	0.753467	-2.205869	1.638809	-2.205869	1.638809
int. rate	1.261186	1.096079	1.150633	0.272295	-1.126966	3.649338	-1.126966	3.649338

EXHIBIT II

Yet the outcomes in Exhibit II continue to support the efficacy of the tax credit. The adjusted R-squared is about the same, at .72. The elasticity on the tax credit variable falls slightly to 1.3, from 1.5 before. But the coefficient remains quite significant, with a t-statistic of 3.65.

The two added variables, the oil price and the interest rate, are not significant. The signs on their two coefficients are even the reverse of that hypothesized. (This does not necessarily mean they did not influence purchase decisions on solar systems at all, just that their causation is masked in the regression by the more important tax credit variable.)

Exhibit III updates the results in both Exhibits I and II with more recent data, from 1977 up to 1998. The Tax Research and Planning Office of the Hawaii Department of Taxation indicates that a time series on systems sold is no longer maintained, so that earlier results cannot be compared directly. However, a very similar time series on total tax returns with energy credit claims is available and was furnished to this reviewer by the Department of Taxation.

Year	returns /wc	tax credit	oil price	interest rate	ln(returns)	ln(tax cred)	ln(oil price)	ln(int rate)
1977	1101	10	13.28	6.99	7.003974137	2.302585093	2.586259144	1.944480556
1978	4256	50	13.39	8.32	8.356085031	3.912023005	2.59450816	2.118662255
1979	4866	50	30.21	9.52	8.490027523	3.912023005	3.408172995	2.253394849
1980	5827	50	36.68	11.48	8.670257567	3.912023005	3.602231647	2.440606391
1981	9908	50	35.27	14.24	9.201097791	3.912023005	3.563032744	2.656054906
1982	8644	50	32.45	13.01	9.064620718	3.912023005	3.479700443	2.565718293
1983	4695	50	29.64	10.8	8.454253392	3.912023005	3.3891248	2.379546134
1984	5433	50	28.55	12.24	8.600246747	3.912023005	3.351656936	2.504709277
1985	7161	50	27.37	10.13	8.876404915	3.912023005	3.309447523	2.315501318
1986	1413	10	14.17	7.31	7.253470383	2.302585093	2.651127054	1.989243274
1987	1016	15	18.2	7.94	6.923628628	2.708050201	2.901421594	2.071913275
1988	484	15	14.77	8.47	6.182084907	2.708050201	2.692598097	2.136530509
1989	390	15	17.91	8.5	5.966146739	2.708050201	2.885359216	2.140066163
1990	1225	35	22.99	8.37	7.110696123	3.555348061	3.135059339	2.124653885
1991	1358	35	19.37	7.37	7.213768308	3.555348061	2.963725477	1.997417706
1992	1492	35	19.04	6.19	7.307872781	3.555348061	2.946542029	1.822935087
1993	2840	35	16.79	5.15	7.951559331	3.555348061	2.820783471	1.638996715
1994	2127	35	15.95	6.68	7.662467815	3.555348061	2.769458829	1.899117988
1995	2668	35	17.2	6.39	7.889084407	3.555348061	2.844909384	1.854734268
1996	3116	35	20.37	6.18	8.044305407	3.555348061	3.01406323	1.821318271
1997	3927	35	19.27	6.22	8.275631055	3.555348061	2.958549482	1.827769907
1998	3987	35	13.07	5.15	8.290794347	3.555348061	2.570319528	1.638996715

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.818112634
R Square	0.669308283
Adjusted R Square	0.614192996
Standard Error	0.552019023
Observations	22

ANOVA					
	df	SS	MS	F	Significance F
Regression	3	11.10154631	3.700515438	12.14378675	0.000139646
Residual	18	5.48505003	0.304725002		
Total	21	16.58659634			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	2.447598	1.103833	2.217361	0.039708	0.128528	4.766669	0.128528	4.766669
tax credit	1.182886	0.306304	3.861805	0.001142	0.539365	1.826408	0.539365	1.826408
oil price	0.195046	0.755370	0.258212	0.799172	-1.391930	1.782022	-1.391930	1.782022
int. rate	0.347955	0.715933	0.486016	0.632819	-1.156166	1.852076	-1.156166	1.852076

The outcomes of Exhibit III corroborate those presented the two previous exhibits. Adjusted R-squared falls somewhat to .61, but t-statistics on the three independent variables tell the same story. The tax credit is still highly significant, with a t-statistic of 3.86. The elasticity is now 1.2, but recall that the dependent variable is somewhat different so that results are not directly comparable to earlier ones. Both the oil price and the interest rate remain insignificant, and the sign on the interest rate in this regression is not correct.

Investigations like these could be supplemented with other regressions using different variables, intervals, and specifications. Perhaps some of these regressions might show greater influence of non-tax credit forces on the solar investment decisions. The addition of DSM effects is one possibility. Yet suffice it to say that those regressions presented here continue to support the causal impact and efficacy of the tax credit, and the lesser importance of other market forces. The fall in the value of the elasticity on the tax credit as the interval is extended may mean that the credit was less effective – per given percentage point of the credit - in later years, as oil prices fell. The return of higher oil prices, as now seems to be occurring, could likewise herald a return to a greater per point response.

Thoughts on Hawaii's Energy Policy Options

Hawaii is far more dependent on oil as a source of its energy needs than any other U.S. state. Other states can rely more heavily on sources such as hydroelectric power, coal, nuclear energy, and natural gas. Oil accounts for about 40 percent of the energy needs of the overall U.S. economy, but it accounts for an overwhelming 90 percent of the needs of Hawaii, with biomass combustion accounting for most of the remaining amount. And the certain demise of the sugar plantations means that bagasse, the remnant of sugar cane processing used for fuel, will be in increasingly short supply.

In turn, about 60 percent of Hawaii's oil consumption is for liquid fuels to power cars, buses, airplanes, and ships. Jet fuel alone accounts for almost 40 percent of our oil consumption. That gets the residents of this isolated island state to the Mainland and other destinations. But more importantly, it brings tourists here. An estimated one-third of Hawaii's jobs are tied in some way to the visitor industry, and tourism will undoubtedly remain Hawaii's most important export industry for the foreseeable future. There is no substitute for jet fuel derived from oil.

Perhaps even more relevant in gauging Hawaii's dependence on oil -- and the state's vulnerability to potential disruptions in oil supplies -- is the fact that it must be shipped over very long distances to be consumed here. The nearest supplier is thousands of miles away.

There is no time like the present for sober reflection on Hawaii's dependence on oil. As this paper is written, oil prices are climbing to their highest levels in years. Hawaii's economy will feel this in a number

of ways, even as the economy is just recovering from an unprecedented decade of very low growth or actual recession.

- Our own transportation costs will be higher. Hawaii residents cannot drive as far as those on the Mainland, but gasoline prices here traditionally run among the highest in the nation anyway.
- Costs of imported items will be higher, and practically everything we consume comes from outside the state.
- Hawaii businesses will have to pay higher prices for running and lighting their facilities.
- Hawaii is especially vulnerable via the tourism linkage. Higher airfares will mean more expensive Hawaii vacations and perhaps fewer tourists.
- Finally, the most critical impact may come from the income effects on a slowing U.S. economy that will also feel the impact of higher oil prices. At the current juncture, Hawaii looks overwhelmingly to the U.S. Mainland for its externally driven growth. Gone are the days when Japan, another energy-vulnerable economy, provided the main impetus to our local growth. An increasingly significant minority among U.S. economic forecasters is raising the probability of impending U.S. recession. This was not the case as recently as a few months ago, but the Federal Reserve may not get its carefully engineered "soft landing" for the U.S. economy. Higher energy prices have been one of the main factors causing downward revisions of upcoming U.S. growth. Hawaii will feel the effects of a slowing U.S. economy acutely, just because much of its present growth can be attributed to injections from the Mainland. This has come not just in more robust tourism figures, but in things like burgeoning offshore real estate demand.

Yet, at the same time Hawaii is vulnerable to oil, it is blessed with more renewable energy resources than most other economies. Among these are wind, sunlight, geothermal heat, flowing water, and ocean resources. Many of these have been tried in the past, but they have not replaced oil mainly because of the costs associated with their production have not been overcome.

Wind power works only when the wind blows, and connection to the electric grid can cause operating problems. Even assuming the best scenario, wind is likely to contribute only a small share of Hawaii's total power generation needs in the future.

With one of the world's most active volcanoes in Hawaii, one might logically expect big attempts to capture the benefits of geothermal conversion. Such technologies have been proven successful in places like New Zealand and Iceland. And even now in Hawaii, the Big Island benefits significantly from commercially produced geothermal energy. Studies indicate the potential for much more development, even though one stumbling block in the past has been social and spiritual conflicts.

Hawaii is surrounded by deep water, and ocean thermal energy conversion has been the subject of experimentation for years. The main problem here, again, is the cost of production.

Finally, Hawaii has more than its share of sunlight, a resource that we exploit via tourism and in other non-energy generation ways also. Solar technology is commercially available and environmentally friendly. Sunlight can generate electricity directly through photovoltaic cells, or it can heat a fluid for conventional power generation. Photovoltaics may make more sense for small systems that are removed from the utility grid, but costs of generation are again high. So electricity generation from the sun often encounters the same cost hurdle as other renewable sources, but solar heated hot water makes the most sense.

The implications for public policy emerging from all this seem to be the following:

- Oil dependent Hawaii should continue to aggressively pursue other energy sources. Higher cost generation now may give way to lower costs in the future as new technologies emerge.
- Subsidy of alternative energy sources is not free, either via tax credits or by other means. But as Hawaii's economy emerges from the lackluster 1990s into a period of sustained higher growth, as it is now doing, higher tax revenues will make such subsidy much more affordable.

- Higher oil prices, such as the world is once again experiencing, make potential benefits of this subsidy greater than before, perhaps much greater. Periods of low oil prices, such as the world has had in recent years, breed complacency about alternative sources. Yet concern comes back with a vengeance as oil prices rise gain.
- Finally, research such as the Loudat paper, and the results presented above in this reviewer's own paper, provide evidence that a tax credit contributes net economic and fiscal benefits, and that this tax credit has indeed been effective in stimulating investment in solar systems over and above more conventional private market forces. It is the role of government to eliminate roadblocks, and to provide incentives for solutions, even if those solutions themselves come from the private sector.